PATENT ABSTRACTS OF JAPAN

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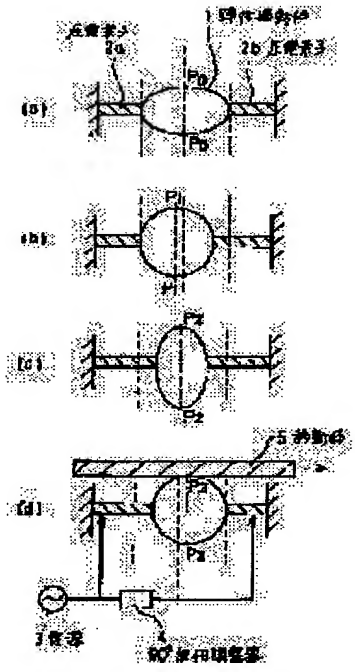
(54) PIEZOELECTRIC DRIVING MOTOR

(57)Abstract:
PURPOSE: To miniaturize a standing wave type of piezoelectric driving motor, and facilitate the control of the direction of normal and reverse driving.
CONSTITUTION: An elastic oscillator 1 is fixed between the mobile ends of a pair of piezoelectric elements 2a and 2b one end each of which is fixed and are counterposed in opposition, and second mode of standing wave oscillation is generated in the elastic oscillator 1 by the deformation of the elastic oscillator 1 at the time of having applied voltage while shifting the phase of each piezoelectric element 2a and 2b 90° , and at the same time, the elastic oscillator 1 causes the shifting of the center of gravity, and the specified point on the elastic oscillator performs elliptic motion, so it becomes possible to drive the mover 5. The driving direction of the mover 5 can be controlled in both normal and reverse directions by shifting the voltage phase applied to each piezoelectric element 2a and 2b $\pi/2$ or $-\pi/2$.



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CLAIMS

[Claim(s)]
[Claim 1] The piezo-electric drive motor characterized by having fixed the end, respectively, having been fixed between the piezoelectric device of the pair which carried out opposite arrangement, and the movable end of each [these] piezoelectric device, and having the elastic vibration object which makes the mobile which deforms and contacts by telescopic motion of each of said piezoelectric device drive, the power source which impresses an electrical potential difference to said each piezoelectric device, and the phase adjuster which shifts 90 degrees of phases of this applied voltage.
[Claim 2] The piezo-electric drive motor characterized by an elastic vibration object being a ring-like in a piezo-electric drive motor according to claim 1.
[Claim 3] It is the piezo-electric drive motor characterized by each piezoelectric device generating flexible distortion according to the piezo-electric longitudinal effect in a piezo-electric drive motor according to claim 1 or 2.
[Claim 4] It is the piezo-electric drive motor characterized by each piezoelectric device generating flexible distortion according to the piezo-electric transversal effect in a piezo-electric drive motor according to claim 1 or 2.
[Claim 5] It is the piezo-electric drive motor characterized by each piezoelectric device being a laminating mold in claim 1 thru/or a piezo-electric drive motor given in four.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the piezo-electric drive motor which takes out mechanical driving force using a piezoelectric device.
[0002]
[Description of the Prior Art] As an advancing-side-by-side drive or a rotation driving source, the electromagnetic motor is known widely conventionally. however, an electromagnetic motor -- electromagnetism -- if there is a problem of propers, such as generating of a noise, and it is made a minute configuration, it has the fault that effectiveness falls. On the other hand, as equipment which transforms the vibrational energy of electrostrictive ceramics into the energy of translational motion or rotation in recent years, an ultrasonic motor is devised variously and attracts attention. this ultrasonic motor -- electromagnetism -- without generating a noise, high torque is realizable at a low speed, and moreover, since the miniaturization is easy, application for the application with which the fault of an electromagnetic motor is compensated is considered.
[0003] By the way, there are a progressive wave type and a standing wave type of ultrasonic motors. Although the progressive wave type ultrasonic motor is excellent to abrasion resistance, it must define severely the dimensional accuracy of an elastic vibration object, and the assembly location precision of a piezoelectric device, and there are many problems in respect of a

miniaturization. The problem is the the best for the built up member of a certain thing being miniaturized, and on the other hand, using them in the small load range to abrasion resistance, since there are few standing wave type ultrasonic motors.

[0004] Drawing 3 is a mimetic diagram for explaining the working principle of a standing wave type ultrasonic motor. In drawing 3 , if high-frequency voltage is impressed to the piezoelectric device 6 which fixed the end by RF generator 7, in contact 8 attached in the movable end of a piezoelectric device 6, vibration will arise in the direction of an arrow head 9 according to input voltage. At this time, since the free end of contact 8 touches the front face of a rotator 10, in contact 8, the standing wave by which vibration of the hand of cut of a rotator 10 and vibration of the flexible direction (arrow head 9) of a piezoelectric device 6 were compounded occurs, consequently a rotator 10 is rotated in the fixed direction.

[0005]

[Problem(s) to be Solved by the Invention] However, control of the hand of cut of right reverse is difficult for a such standing wave type ultrasonic motor, and it needs the amelioration. It is made in order that this invention may solve this point, and that purpose can control the hand of cut of right reverse easily, and it is in moreover offering the piezo-electric drive motor of a miniaturization possible standing wave type.

[0006]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the piezo-electric drive motor of this invention fixes an end, and fixes an elastic vibration object between the movable end of the piezoelectric device of the pair which carried out opposite arrangement, and it is made to make the mobile in contact with this elastic vibration object drive according to deformation of the elastic vibration object when being able to shift 90 degrees of phases to each piezoelectric device, and impressing an electrical potential difference to it.

[0007]

[Function] Since an elastic vibration object produces migration of a center of gravity and the specifying point on an elastic vibration object carries out ellipse movement at the same time it makes an elastic vibration object generate standing wave vibration of the secondary mode by constituting the piezo-electric drive motor of this invention as mentioned above, the mobile in contact with this point can be driven. the electrical-potential-difference phase impressed to each piezoelectric device -- it can shift [pi/2 or] -pi/2 -- the driving direction of a mobile -- forward -- reverse -- controlling to all is possible.

[0008]

[Example] Hereafter, the example of this invention is explained based on a drawing. Drawing 1 (a) - (d) is a mimetic diagram for explaining the working principle of the piezo-electric drive motor of this invention. Drawing 1 (a) expresses the initial state before electrical-potential-difference impression. Two piezoelectric-device 2a and 2bs on the same center line as the elastic vibration object 1 are contacted so that the elastic vibration object 1 may be inserted by the end, respectively, and they are arranged, and each other end of piezoelectric-device 2a and 2b is fixed. It passes along the core of the elastic vibration object 1, and two intersections of the straight line and the elastic vibration object 1 which cross an above-mentioned center line and an above-mentioned perpendicular are set to P0.

[0009] The condition of having impressed the electrical potential difference V to the direction of piezoelectric-device 2b here is drawing 1 (b). Although about 90 degrees of electrical-potential-difference impression are performed with a power source 3 using the phase regulator 4, for convenience, these are illustrated to drawing 1 (d) and omitted to drawing 1 (a) - (c). When an electrical potential difference V is impressed to piezoelectric-device 2b, the elastic vibration object 1 is the point P0 on the elastic vibration object 1 while it deforms and a center of gravity moves. Point P1 It moves.

[0010] Next, when an electrical potential difference V is impressed to piezoelectric-device 2a as it is, like drawing 1 (c), it deforms further, a center of gravity returns, and the elastic vibration object 1 is a point P1. Point P2 It moves.

[0011] Subsequently, when the electrical potential difference V which was being impressed to piezoelectric-device 2b is set to 0, it deforms again, a center of gravity shifts to the opposite side,

and the elastic vibration object 1 is a point P2 like drawing 1 (d). Point P3 It moves. Then, if the electrical potential difference V which was being impressed to piezoelectric-device 2a is set to 0, the elastic vibration object 1 will deform further again, and will return to the condition of drawing 1 (a).

[0012] Drawing 1 (a) By carrying out by repeating the condition of - (d), it is the point P0 of the elastic vibration object 1. It is this point P0 by carrying out ellipse movement and driving at high speed. The mobile 5 which touches will move towards ellipse movement. In addition, also about this mobile 5, for convenience, it illustrates to drawing 1 (d) and has omitted to drawing 1 (a) - (c). The time of the elastic vibration object 1 performing standing wave vibration of the secondary mode drives most efficiently.

[0013] Although drawing 2 is an electrical-potential-difference wave form chart impressed to each piezoelectric-device 2a and 2b, an upper case expresses piezoelectric-device 2a and the lower berth expresses piezoelectric-device 2b, each process [of drawing 1 corresponding to time series] (a) - (d) is written together. As drawing 2 shows, a voltage waveform is the square wave from which the phase shifted pi/2 in piezoelectric-device 2a and 2b. When moving a mobile 5 to hard flow, it is the phase of applied voltage. - It becomes possible by shifting pi/2.

[0014] The drive of piezoelectric-device 2a and 2b may use a laminating mold piezoelectric device, in order to adopt any of vibration by the piezo-electric longitudinal effect, and vibration by the piezo-electric transversal effect and to take the large amplitude. Although the elastic vibration object 1 of considering as the about [thickness 1mm] shape of the diameter of 5-10mm and a ring is good, even if it uses the thing of an ellipse form or other configurations, it can acquire the same effectiveness. About wear of the elastic vibration object 1, it can be coped with by choosing the suitable ingredient for the elastic vibration object 1, and making hardness of the elastic vibration object 1 larger than the hardness of a mobile 5. Since structure is very simple, the piezo-electric drive motor of this invention constituted as mentioned above is easy to miniaturize.

[0015]

[Effect of the Invention] Since the piezo-electric drive motor of this invention constituted as a subject the elastic vibration object which fixed the end and was fixed between the piezoelectric device of the pair which carried out opposite arrangement, and the movable end of each piezoelectric device as stated so far Since an elastic vibration object is made to generate standing wave vibration of the secondary mode, an elastic vibration object produces migration of a center of gravity in coincidence and the specifying point on an elastic vibration object carries out ellipse movement, it becomes possible to drive the mobile in contact with this point. And control of the driving direction of the right reverse of a mobile can perform the phase of the applied voltage of each piezoelectric device pi/2 or by the ability shifting -pi/2. Since the piezo-electric drive motor of this invention is easy structure, it is still easier to miniaturize.

TECHNICAL FIELD

[Industrial Application] This invention relates to the piezo-electric drive motor which takes out mechanical driving force using a piezoelectric device.

PRIOR ART

[Description of the Prior Art] As an advancing-side-by-side drive or a rotation driving source, the electromagnetic motor is known widely conventionally. however, an electromagnetic motor -- electromagnetism -- if there is a problem of propers, such as generating of a noise, and it is made a minute configuration, it has the fault that effectiveness falls. On the other hand, as equipment which transforms the vibrational energy of electrostrictive ceramics into the energy of translational motion or rotation in recent years, an ultrasonic motor is devised variously and attracts attention. this ultrasonic motor -- electromagnetism -- without generating a noise, high torque is realizable at a low speed, and moreover, since the miniaturization is easy, application for the application with which the fault of an electromagnetic motor is compensated is considered.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since the piezo-electric drive motor of this invention constituted as a subject the elastic vibration object which fixed the end and was fixed between the piezoelectric device of the pair which carried out opposite arrangement, and the movable end of each piezoelectric device as stated so far, Since an elastic vibration object is made to generate standing wave vibration of the secondary mode, an elastic vibration object produces migration of a center of gravity in coincidence and the specifying point on an elastic vibration object carries out ellipse movement, it becomes possible to drive the mobile in contact with this point. And control of the driving direction of the right reverse of a mobile can perform the phase of the applied voltage of each piezoelectric device pi/2 or by the ability shifting -pi/2. Since the piezo-electric drive motor of this invention is easy structure, it is still easier to miniaturize.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, control of the hand of cut of right reverse is difficult for a such standing wave type ultrasonic motor, and it needs the amelioration. It is made in order that this invention may solve this point, and that purpose can control the hand of cut of right reverse easily, and it is in moreover offering the piezo-electric drive motor of a miniaturization possible standing wave type.

MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the piezo-electric drive motor of this invention fixes an end, and fixes an elastic vibration object between the movable end of the piezoelectric device of the pair which carried out opposite arrangement, and it is made to make the mobile in contact with this elastic vibration object drive according to deformation of the elastic vibration object when being able to shift 90 degrees of phases to each piezoelectric device, and impressing an electrical potential difference to it.

OPERATION

[Function] Since an elastic vibration object produces migration of a center of gravity and the specifying point on an elastic vibration object carries out ellipse movement at the same time it makes an elastic vibration object generate standing wave vibration of the secondary mode by constituting the piezo-electric drive motor of this invention as mentioned above, the mobile in contact with this point can be driven. the electrical-potential-difference phase impressed to each piezoelectric device -- it can shift [pi/2 or] -pi/2 -- the driving direction of a mobile -- forward -- reverse -- controlling to all is possible.

EXAMPLE

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] (a) - (d) is a mimetic diagram for explaining the working principle of the piezo-electric drive motor of this invention.
[Drawing 2] The electrical-potential-difference wave form chart impressed to a piezoelectric device
[Drawing 3] The mimetic diagram for explaining the working principle of a standing wave type ultrasonic motor
[Description of Notations]
1 Elastic Vibration Object
2a Piezoelectric device
2b Piezoelectric device
3 Power Source
4 At Least 90 " is Phase Regulator.
5 Mobile
6 Piezoelectric Device
7 RF Generator
8 Contact
10 Rotator

[Translation done.]

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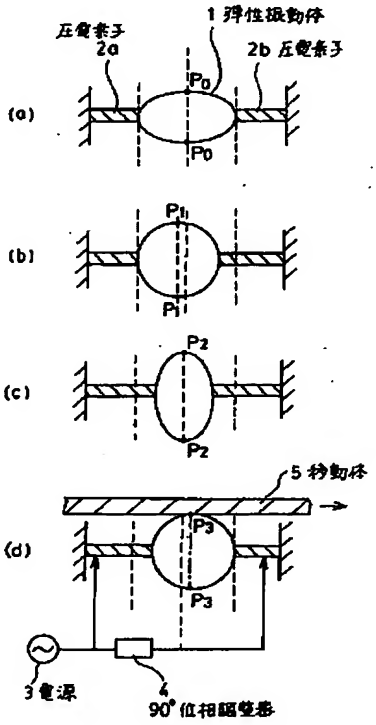
(54)【発明の名称】　圧電駆動モータ

(57)【要約】　(修正有)

【目的】定在波タイプの圧電駆動モータを小型化し正逆駆動方向の制御を容易にする。

【構成】本発明の圧電駆動モータは、一端を固定し対向配置した一対の圧電素子２ａ，２ｂの可動端の間に弾性振動体１を固定し、各圧電素子２ａ，２ｂに位相を９０°ずらせて電圧を印加したときの弾性振動体１の変形により、弾性振動体１に２次モードの定在波振動を発生させ、同時に弾性振動体１は重心の移動を生じ、弾性振動体上の特定点が楕円運動するので、この点に接触する移動体５を駆動させることが可能となる。各圧電素子２ａ，２ｂに印加する電圧位相をπ／２または－π／２ずらせることにより、移動体５の駆動方向を正逆いずれにも制御することができる。



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【特許請求の範囲】

【請求項１】それぞれ一端を固定し対向配置した一対の圧電素子と、これら各圧電素子の可動端の間に固定されて前記各圧電素子の伸縮によって変形し接触する移動体を駆動させる弾性振動体と、前記各圧電素子に電圧を印加する電源と、この印加電圧の位相を９０°ずらす位相調整器とを備えたことを特徴とする圧電駆動モータ。

【請求項２】請求項１記載の圧電駆動モータにおいて、弾性振動体がリング状であることを特徴とする圧電駆動モータ。

【請求項３】請求項１または２記載の圧電駆動モータにおいて、各圧電素子は、圧電縦効果により伸縮歪みを発生することを特徴とする圧電駆動モータ。

【請求項４】請求項１または２記載の圧電駆動モータにおいて、各圧電素子は、圧電横効果により伸縮歪みを発生することを特徴とする圧電駆動モータ。

【請求項５】請求項１ないし４記載の圧電駆動モータにおいて、各圧電素子は、積層型であることを特徴とする圧電駆動モータ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は圧電素子を用いて機械的な駆動力を取り出す圧電駆動モータに関する。

【０００２】

【従来の技術】並進駆動または回転駆動源として、従来電磁式モータが広く知られている。しかし、電磁式モータは電磁ノイズの発生などの固有の問題があり、また微小な形状にすると効率が低下するという欠点を持っている。これに対して、近年圧電セラミックスの振動エネルギーを並進運動または回転運動のエネルギーに変換する装置として、超音波モータが種々考案され注目されている。この超音波モータは電磁ノイズを発生することなく、低速で高いトルクを実現することができ、しかも小型化が容易であるから、電磁式モータの欠点を補う用途への適用が検討されている。

【０００３】ところで、超音波モータには進行波タイプと定在波タイプとがある。進行波タイプの超音波モータは耐磨耗性に対しては優れているが、弾性振動体の寸法精度や、圧電素子の組立位置精度を厳しく定めねばならないので、小型化の点で問題が多い。一方、定在波タイプの超音波モータは耐磨耗性に対して問題はあるものの、組立部材が少ないので、小型化して小さい負荷範囲で使用するには最適である。

【０００４】図３は定在波タイプの超音波モータの作動原理を説明するための模式図である。図３において、一端を固定した圧電素子６に、高周波電源７により高周波電圧を印加すると、圧電素子６の可動端に取り付けてある接触子８には、入力電圧に応じて矢印９の方向に振動が生ずる。このとき接触子８の自由端は、回転子１０の表面に接触しているので、接触子８には回転子１０の回

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転方向の振動と、圧電素子６の伸縮方向（矢印９）の振動が合成された定在波が発生し、その結果、回転子１０は一定方向に回転する。

【０００５】

【発明が解決しようとする課題】しかしながら、このような定在波タイプの超音波モータは、正逆の回転方向の制御が困難であり、その改良が必要である。本発明はこの点を解決するためになされたものであり、その目的は正逆の回転方向を容易に制御することができ、しかも小型化の可能な定在波タイプの圧電駆動モータを提供することにある。

【０００６】

【課題を解決するための手段】上記の課題を解決するために、本発明の圧電駆動モータは、一端を固定し対向配置した一対の圧電素子の可動端の間に弾性振動体を固定し、各圧電素子に位相を９０°ずらせて電圧を印加したときの弾性振動体の変形により、この弾性振動体に接触する移動体を駆動させるようにしたものである。

【０００７】

【作用】本発明の圧電駆動モータは、上記のように構成することにより、弾性振動体に２次モードの定在波振動を発生させると同時に、弾性振動体は重心の移動を生じ、弾性振動体上の特定点が楕円運動するので、この点に接触する移動体を駆動することができる。各圧電素子に印加する電圧位相を$\pi/2$または$-\pi/2$ずらせることにより、移動体の駆動方向を正逆いずれにも制御することが可能である。

【０００８】

【実施例】以下、本発明の実施例を図面に基づき説明する。図１（ａ）～（ｄ）は本発明の圧電駆動モータの作動原理を説明するための模式図である。図１（ａ）は電圧印加前の初期状態を表す。弾性振動体１と同一中心線上にある二つの圧電素子２ａと２ｂをそれぞれ一端で弾性振動体１を挟むように接触させて配置し、圧電素子２ａ，２ｂの他端はいずれも固定してある。弾性振動体１の中心を通り、上記の中心線と垂直に交わる直線と弾性振動体１との二つの交点をP_0とする。

【０００９】ここで圧電素子２ｂの方に電圧Ｖを印加した状態が図１（ｂ）である。電圧印加は電源３と、９０°位相調整器４を用いて行なうが、これらは便宜上、図１（ｄ）にのみ図示し図１（ａ）～（ｃ）には省略してある。圧電素子２ｂに電圧Ｖを印加すると、弾性振動体１は変形して重心が移動するとともに、弾性振動体１上の点P_0は点P_1に移動する。

【００１０】次に、このまま圧電素子２ａに電圧Ｖを印加すると、図１（ｃ）のように弾性振動体１はさらに変形し、重心は元に戻り点P_1は点P_2に移動する。

【００１１】次いで圧電素子２ｂに印加していた電圧Ｖを０にすると、弾性振動体１は再び変形して重心は反対側に移行し、図１（ｄ）のように点P_2は点P_3に移動

する。続いて圧電素子２ａに印加していた電圧Ｖを０にすると、弾性振動体１は再びさらに変形し、図１（ａ）の状態に戻る。

【００１２】図１（ａ）～（ｄ）の状態を繰り返し行なうことにより、弾性振動体１の点P_0は楕円運動し、高速で駆動することにより、この点P_0に接触している移動体５は楕円運動の方向に移動することになる。なお、この移動体５についても、便宜上、図１（ｄ）にのみ図示し図１（ａ）～（ｃ）には省略してある。弾性振動体１が２次モードの定在波振動を行なっているときが最も効率よく駆動される。

【００１３】図２は各圧電素子２ａと２ｂに印加する電圧波形図であり、上段が圧電素子２ａを表わし下段が圧電素子２ｂを表わしているが、時系列に対応する図１の各過程（ａ）～（ｄ）を併記してある。図２からわかるように、電圧波形は圧電素子２ａと２ｂで位相がπ／２ずれた矩形波である。移動体５を逆方向に移動させるときは、印加電圧の位相を－π／２ずらすことにより可能となる。

【００１４】圧電素子２ａ，２ｂの駆動は、圧電縦効果による振動と、圧電横効果による振動のいずれを採用してもよく、また、振幅を大きくとるために積層型圧電素子を用いてもよい。弾性振動体１は、例えば直径５～１０mm，肉厚１mm程度のリング状とするのがよいが、楕円形やその他の形状のものを用いても同様の効果を得ることができる。弾性振動体１の磨耗については、弾性振動体１に適切な材料を選び、移動体５の硬さより弾性振動体１の硬さを大きくすることにより、対処することができる。以上のように構成した本発明の圧電駆動モータは、構造が非常にシンプルであるから、小型化も容易である。

【００１５】

【発明の効果】本発明の圧電駆動モータは、これまで述べてきたように、一端を固定し対向配置した一対の圧電素子と、各圧電素子の可動端の間に固定した弾性振動体とを主体として構成したために、弾性振動体に２次モードの定在波振動を発生させ、同時に弾性振動体は重心の移動を生じ、弾性振動体上の特定点が楕円運動するので、この点に接触する移動体を駆動することが可能となる。そして移動体の正逆の駆動方向の制御は、各圧電素子の印加電圧の位相をπ／２または－π／２ずらせることにより行なうことができる。さらに本発明の圧電駆動モータは、簡単な構造であるから小型化が容易である。

【図面の簡単な説明】

【図１】（ａ）～（ｄ）は本発明の圧電駆動モータの作動原理を説明するための模式図

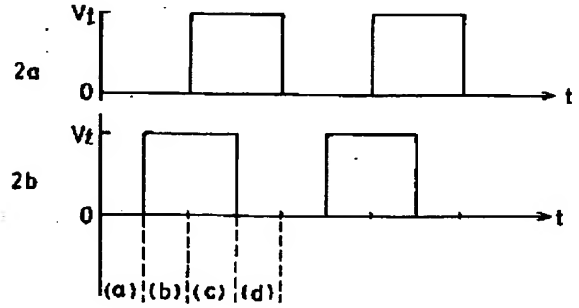
【図２】圧電素子に印加する電圧波形図

【図３】定在波タイプの超音波モータの作動原理を説明するための模式図

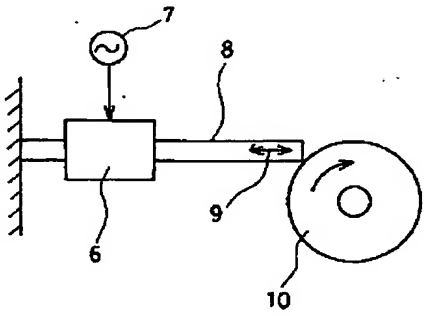
【符号の説明】

１　弾性振動体
２ａ　圧電素子
２ｂ　圧電素子
３　電源
４　９０°位相調整器
５　移動体
６　圧電素子
７　高周波電源
８　接触子
１０　回転子

【図２】



【図３】



【図１】